Substituted Diphenylamines
Category Justification and Testing Rationale

CAS Nos. 68411-46-1, 68442-68-2, 184378-08-3, 15721-78-5, 101-67-7, 36878-20-3, 68608-77-5 and 68921-45-9
(+ SIDS Chemical 122-39-4 for data purposes)

Rubber and Plastic Additives Panel
American Chemistry Council
December 2001

List of Member Companies in the Rubber and Plastic Additives Panel

The Rubber and Plastic Additives (RAPA) Panel of the American Chemistry Council (ACC) includes the following member companies: Bayer Corporation, Ciba Specialty Chemicals Corporation, Crompton Corporation, Flexsys America L.P., The Goodyear Tire & Rubber Company, The Lubrizol Corporation, Noveon, Inc., R.T. Vanderbilt Company, Inc., and UOP, LLC.

Executive Summary

The ACC's RAPA Panel, and its member companies, hereby submit for review and public comment the category justification and test plan for the Substituted Diphenylamines category of chemicals under the Environmental Protection Agency's (EPA's) High Production Volume (HPV) Challenge Program.

As discussed in the report that follows, Substituted Diphenylamines, which are used as antidegradants in rubber, foamed polymers and high-temperature functional fluids (lubricants, gear oils, hydraulic fluids), are defined as diamines with various substitutions. Their use in these applications requires stability at high temperatures, low biodegradation, low water solubility and low vapor pressure. Existing data for members of this category indicate that they are of low concern for mammalian toxicity.

In consideration of animal welfare concerns to minimize the use of animals in the testing of chemicals, the Panel has conducted a thorough literature search for all available data, published and unpublished. It has also performed an analysis of the adequacy of the existing data. Further, it developed a scientifically supportable category of related chemicals and used structure-activity relationship information to address certain data requirements. As a result of these efforts, no additional testing is proposed for the chemicals in the Substituted Diphenylamines category for the purposes of the HPV Program.

Substituted Diphenylamines Category

Relying on several factors specified in EPA's guidance document on "Development of Chemical Categories in the HPV Challenge Program," in which use of chemical categories is encouraged, the following closely related chemicals constitute a chemical category:

Benzeneamine, N-phenyl- (122-39-4)[1]
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)
Benzenamine, N-phenyl-, styrenated (68442-68-2)
Benzenamine, N-phenyl- (184378-08-3)
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)[2]
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)

Structural Similarity. A key factor supporting the classification of these chemicals as a category is their structural similarity (see Figure 1). All share a common starting material; Diphenylamine (Benzenamine, N-phenyl-, CAS# 122-39-4), a common synthetic pathway, and all compounds in this category are diamines with various substitutions.

Similarity of Physicochemical Properties. The similarity of the physicochemical properties of these materials parallels their structural similarity. All are off-white to light brown solids or viscous liquids intended for use as antioxidants in finished rubber articles or as antidegradant additives that extend the useful life of heavy-duty industrial functional fluids used in high-speed, high-temperature and/or high-load applications. As a class, these amine-based antidegradant compounds are less migratory (more polymer-bound) and less staining than the Substituted p-Phenylenediamine antidegradants. The use of these materials requires that they be stable under high temperatures. Their low volatility is due to their low vapor pressure, highly viscous or solid form. The existing information for these materials indicates that they have low water solubility and high flash points.

Fate and Transport Characteristics. Members of this category have been shown to be not readily biodegradable, so additional testing is not needed. The lack of water solubility of the members of this category makes hydrolysis testing unnecessary. Adequate information regarding photodegradation is available for meeting HPV Program requirements, therefore, additional data collection efforts are not necessary. These materials have been shown not to partition to water or air if released into the environment due to their low water solubility and low vapor pressure; the exception being Benzenamine, N-phenyl – (122-39-4) where the absence of alkyl groups on the diphenylamine molecule results in a greater water solubility and, therefore, more likely to partition to water as compared to the other category members. For the purposes of the HPV Program, additional computer-modeled environmental partitioning data is not necessary for the members of this category.

Toxicological Similarity. Review of existing published and unpublished test data for Substituted

[1] Listed under the OECD SIDS Program
[2] Not HPV under definition of 1990 IUR. This material is HPV under the 1994 IUR.

Diphenylamines shows the aquatic and mammalian toxicity among the materials within this category are similar.

Aquatic Toxicology. Data on acute fish toxicity, acute invertebrate toxicity, and alga toxicity were reviewed. With increasing molecular weight, the toxicity to aquatic organisms decreases. For the purposes of the HPV Program, additional testing is not proposed for the members of this category.

Mammalian Toxicology - Acute. Data on acute mammalian toxicity were reviewed, and the findings indicate a low concern for acute toxicity for all materials. Data are available for most members of the category indicating that the category has been well tested for acute mammalian effects. Therefore, for the purposes of the HPV Program, no additional acute mammalian toxicity testing is proposed.

Mammalian Toxicology - Mutagenicity. Data from bacterial reverse mutation assays, *in vitro* and *in vivo* chromosome aberration studies, as well as additional supporting *in vitro* and *in vivo* genetic toxicity studies were reviewed, and the findings indicate a low concern for mutagenicity. Data are available for several members of the category or close structural analogs, and these data can be bridged to the other members of the category. Therefore, for the purposes of the HPV Program, the category has been adequately tested for mutagenicity, and no additional mutagenicity testing is proposed.

Mammalian Toxicology – Repeated Dose Toxicity. Data from repeated-dose toxicity studies were reviewed. Sufficient data are available for the Substituted Diphenylamines for the purposes of the HPV Program, and therefore, no additional testing is planned.

Mammalian Toxicology - Reproductive and Developmental Toxicity. Data from reproductive and developmental toxicity studies were reviewed. Sufficient data are available for the Substituted Diphenylamines, and for the purposes of the HPV Program, and therefore, no additional testing is planned.

Conclusion. Based upon the data reviewed in the report, the physicochemical and toxicological properties of the Substituted Diphenylamine category members are similar and follow a regular pattern as a result of that structural similarity. Therefore, the EPA definition of a chemical category has been met.

As this test plan was developed, careful consideration was given to the number of animals that would be required for tests included in the proposed plan and conditions to which the animals might be exposed. In consideration of concerns about animal welfare, the use of animals in the proposed test plan has been minimized. The test plan is also included as Table 8 of this document.

Introduction

A provision for the use of structure activity relationships (SAR) to reduce testing needs is included under EPA's HPV Program. Specifically, categories may be formed based on structural similarity, through analogy, or through a combination of category and analogy for use with single chemicals. The benefits of using a category approach are numerous and include accelerated release of hazard information to the public; reduction in the number of animals used for testing; and an economic savings as a result of a reduced testing program.

The Substituted Diphenylamines materials that form this category based on structural similarity are:

Benzeneamine, N-phenyl- (122-39-4)
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)
Benzenamine, N-phenyl-, styrenated (68442-68-2)
Benzenamine, N-phenyl- (184378-08-3)
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)

The materials were further arranged in order of molecular weight, so that the smallest material is listed first, and materials listed subsequently have increasingly larger molecular weights. All of these materials (except Benzeneamine, N-phenyl- (122-39-4) and Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)) are listed under the HPV Program. Benzeneamine, N-phenyl- (122-39-4) is under evaluation in the Organization for Economic Co-operation and Development (OECD) Screening Information Data Set (SIDS) program. Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5) is not listed in the HPV Program because it was not an HPV chemical in 1990, however it was produced in sufficient volume to meet HPV criteria in 1994.

Benzeneamine, N-phenyl- (122-39-4) is extremely well characterized, with adequate repeat dose, reproductive and developmental toxicity data, metabolic fate data, is a registered FIFRA pesticide with a pesticide tolerance on apples of 10 ppm and a daily human dose of 0.025 mg/kg, and is FDA approved for five different uses, including Rubber Articles (177.2600). Human exposure to Diphenylamine derivatives that are used as rubber and oil antidegradants at levels of 5% or less is minimal when compared to exposure to Benzeneamine, N-phenyl- (122-39-4) as a pesticide and as an edible residue. In addition, three of the six chemicals in this category (68411-96-1, 68442-68-2 and 101-67-7) have FDA approvals.

The development of this category follows current EPA guidance[3].

Background Information: Manufacturing and Commercial Applications

Manufacturing

A common synthetic pathway in the production of Substituted Diphenylamines is via a process known as reductive alkylation. The common starting material, Diphenylamine, (or Benzenamine, N-phenyl-) is reacted with an olefin containing the desired substituent group(s) in the presence of hydrogen. The resulting reaction product is typically purified by distillation.

[3] US EPA, Office of Pollution Prevention and Toxics. Development of Chemical Categories, Chemical Right-to-Know Initiative. http://www.epa.gov/opptintr/chemrtk/categuid.htm

Commercial Applications

Substituted Diphenylamines materials are highly effective and active antioxidants in natural and many types of synthetic rubbers. They also impart heat-resistance and flex-fatigue resistance to rubber articles used in high-temperature and dynamic applications, such as under-the-hood automotive belts, gaskets and bushings. Because of their relatively non-staining and non-migratory nature, some Substituted Diphenylamines are used in the manufacture of light-colored rubber articles and adhesives that may contact food. Typical use percentage for a Substituted Diphenylamine in rubber compounding is 1-4 parts for every 100 parts of rubber. In heavy-duty functional fluids, Substituted Diphenylamines are powerful antioxidants that extend the useful life of transmission fluids, gear oils, lubricants and hydraulic fluids that must retain their properties in high-speed, high-temperature and/or high-load applications. Typical use percentage for a Substituted Diphenylamine as a functional fluid antioxidant is 1-4%.

Due to their powerful antioxidant properties, Substituted Diphenylamines, along with their common starting material, Diphenylamine, are regulated for use in several food-contact applications by the Food and Drug Administration as Indirect Food Additives under the following sections of 21 CFR:

175.105	Components of Adhesives	Diphenylamine, 101-67-7
175.300	Resinous and Polymeric Coatings	Diphenylamine
176.170	Components of Paper/Paperboard – Fatty Food	Diphenylamine
176.180	Components of Paper/Paperboard – Dry Food	Diphenyalmine
177.1210	Closures with Sealing Gaskets	68411-46-1
177.2600	Rubber Articles	Diphenylamine, 101-67-7
178.2010	Antioxidants/Stabilizers for Polymers	68411-46-1, 68422-68-2
178.3570	Lubricants with Food Contact	68411-46-1

Shipping/Distribution

Substituted Diphenylamines materials are shipped extensively throughout the world from manufacturing plants in the USA, Eastern and Western Europe and Japan. Container types vary with physical form, quantity of material and destination. Boxes, bags of varying sizes, drums, tote tanks and tank cars can be used to transport Substituted Diphenylamines.

Worker/Consumer Exposure

The rubber and plastics additives industry has a long safety record and sophisticated users handle materials. Exposure of workers handling Substituted Diphenylamine materials is likely to be the highest in the areas of material packaging at the manufacturing site and during raw material weigh-up at the customer site. These materials are produced as dust-suppressed powders, flakes, and viscous liquids. Thus, during the above operations, there is some potential for inhalation exposure (nuisance dust is the primary route of worker exposure) and dermal contact to liquid forms.

Development of the Substituted Diphenylamines Category

EPA has described a stepwise process for developing categories. These steps include:

- Grouping a series of like chemicals, including the definition of criteria for the group.
- Gathering data on physicochemical properties, environmental fate and effects, and health effects for each member of the category.
- Evaluating the data for adequacy.
- Constructing a matrix of available and unavailable data.
- Determining whether there is a correlation among category members and data gathered.

Definition of the Substituted Diphenylamines Category

As defined by EPA under the HPV Program, a chemical category is "a group of chemicals whose physicochemical and toxicological properties are likely to be similar or follow a regular pattern as a result of structural similarity." The similarities should be based on a common functional group, common precursors or breakdown products (resulting in structurally similar chemicals) and an incremental and constant change across the category. The goal of developing a chemical category is to use interpolation and/or extrapolation to assess chemicals rather than conducting additional and unnecessary testing.

The materials within the Substituted Diphenylamines category, for the purposes of the HPV Program, are defined as diamines, which vary with the degree of alkyl or phenyl groups, as illustrated in Figure 1. Chemical structures for these materials are provided in Figure 2. The lack of water solubility, low vapor pressure, and inability to biodegrade are similar for the substituted diphenylamines (see Table 1). Furthermore, these materials are not flammable.

Matrix of SIDS Endpoints

In order to construct a matrix of SIDS endpoints for the members of the substituted diphenylamines category, the data on physicochemical properties, environmental fate and effects, and health effects for each member of the category must be collected and evaluated for adequacy. The results of these activities are presented in the tables and text below, providing a matrix of available data.

Correlation within the Substituted Diphenylamines Category

The matrix data patterns for physicochemical properties; environmental fate, ecotoxicity; and health effects have been evaluated for the members of the Substituted Diphenylamine category. A description of the results of this evaluation follows.

Correlation of Physicochemical Properties

The physicochemical properties of the members of the Substituted Diphenylamine category are presented in Table 2. These materials may exist as liquids or solids at room temperature, such that melting point or boiling point data may not be relevant for varying members of the category. The similarities in the other

physicochemical properties of these materials, which are described below, are explained by similarities in their chemical structure, and provide justification of this group of chemicals as a category within the HPV Challenge Program.

The members of this category have a wide range of melting points and boiling points (varying based on the physical state as a liquid or solid). All the members of this category have very low vapor pressures, as indicated in Table 2. Data for the members of this category clearly indicate a lack of water solubility or negligible water solubility. Partition coefficient data fall into two ranges, from ~4 to 6 and from ~10 to 12.

For the purposes of the HPV Program, bridging to other members of the category will address outstanding physicochemical properties data requirements, as illustrated below.

Physicochemical properties data (melting point, vapor pressure, and boiling point) for Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1) will be bridged to Benzenamine, N-phenyl-, styrenated (68442-68-2). Physicochemical properties data (vapor pressure and boiling point) for Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) will be bridged to Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3). Melting point data for Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3) will be bridged to Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5) and Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9).

Correlation of Environmental Fate

The members of this category are found to be not readily biodegradable, have rapid photodegradation half-lives, and modeling shows a primary partitioning to soil and sediment fractions (vs. water), with the exception of Diphenylamine (Table 3). This is expected as diphenylamine (Benzenamine, N-phenyl – (122-39-4)) does not have alkyl groups onto the diphenylamine molecule, resulting in a greater water solubility and, therefore, more likely to partition to water than other members of the category. Hydrolysis data are not available for these materials, as discussed below.

The HPV Challenge Program requires that hydrolysis, photodegradation, biodegradation and environmental transport information be presented for each material or bridged to each member of a category. Adequate biodegradation data exist for the several of the materials in this category; bridging will be used to address the remaining biodegradation data requirements as illustrated below. The results presented indicate that these materials are poorly biodegradable. Hydrolysis testing of the members of this category is not appropriate since they are not water-soluble. Photodegradation studies presented for several members of this category are adequate; bridging will be used to fill the remaining photodegradation data requirements as illustrated below. Finally, fugacity modeling has been conducted on several of the members of this category, with consistent results showing partitioning to soil and sediment; with the exception noted above for diphenylamine. This is consistent with the lack of water solubility and low vapor pressure of these materials. For the purposes of the HPV Program, bridging to other members of the category will address outstanding environmental fate data requirements, as illustrated below.

The photodegradation information from Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1) and Benzenamine, N-phenyl- (184378-08-3) will be bridged to Benzenamine, N-phenyl-, styrenated (68442-68-2). The photodegradation information from Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5) and Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5) will be bridged to Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) and Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3).

The biodegradation data from Benzenamine, N-phenyl-, styrenated (68442-68-2) and Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3) will be bridged to Benzenamine, N-phenyl- (184378-08-3), and Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7). The biodegradation data from Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3) will be bridged to Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5) and Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9).

Environmental Transport modeling will be bridged from Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1) to Benzenamine, N-phenyl-, styrenated (68442-68-2). Environmental Transport modeling will be bridged from Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5) and Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5) to Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) and Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3).

Correlation of Ecotoxicity

The HPV Challenge Program requires that an acute aquatic ecotoxicity test in fish, invertebrates, and algae be performed or bridged to each member of a category. Existing data (Table 2) indicate that all members of the Substituted Diphenylamine category have low water solubility. The low water solubility suggests that the acute aquatic toxicity of these materials should be low due to limited bioavailability to aquatic organisms. Sufficient data is available to meet HPV Program requirements for the toxicity of the Substituted Diphenylamines to aquatic organisms (Table 4). As the molecular weight of the category members increases, there is a clear reduction in the acute aquatic toxicity of these materials. For the purposes of the HPV Program, bridging from this data will be used to address the data information requirements for the remainder of this category as illustrated below.

The EPIWIN data for Benzeneamine, N-phenyl- (122-39-4), and data from Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) , Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1), Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3), and Benzenamine, N-phenyl-, styrenated (68442-68-2) will be bridged to the remaining members of this category.

Correlation of Health Effects

Acute Mammalian Toxicity

Acute oral and dermal toxicity data for the category are summarized in Table 5. Of the Substituted Diphenylamines tested, all show a slight to very low order of toxicity following oral administration, with LD_{50} values ranging from >500 to > 34,000 mg/kg. Overall, the acute dermal LD_{50} for these materials was greater than the 2000 mg/kg limit dose indicating a very low order of toxicity.

Numerous adequate acute toxicity studies have been conducted for the Substituted Diphenylamine category using two routes of exposure (oral and dermal); and the toxicity of four of the nine members of the category has been evaluated. The data demonstrate a slight to very low order of acute toxicity. The similarity in the order of toxicity for these materials is consistent with their similar chemical structure and physicochemical properties and supports the scientific justification of these materials as a category within the HPV Challenge Program.

The HPV Challenge Program requires that either an acute test be performed or bridged to each member of a category. Adequate acute oral toxicity tests exist for five of the nine Substituted Diphenylamines; for the purposes of the HPV Program, bridging will be used to fill the remaining data requirements as follows.

Acute oral toxicity data from Benzenamine, N-phenyl-, styrenated (68442-68-2) and Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) will be bridged to Benzenamine, N-phenyl- (184378-08-3) and Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5). Acute oral toxicity data from Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) will be bridged to Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3). Acute oral toxicity data from Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5) will be bridged to Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9).

By bridging existing data to the materials for which data were not identified, the acute toxicity of the category has met requirements of the HPV Program with respect to all acute toxicity endpoints, and therefore, no additional acute toxicity testing is proposed.

Mutagenicity

A summary of the mutagenicity information for the Substituted Diphenylamines category is presented in Table 6. The weight of evidence for the members of this category indicates these materials are not mutagenic.

Adequate bacterial mutagenicity tests exist for five of the nine Substituted Diphenylamines category; bridging will be used to address the remaining data requirements for the purposes of the HPV Program. Adequate *in vitro* chromosome aberration tests or *in vivo* micronucleus tests exist for three of the nine materials in the Substituted Diphenylamines category; bridging will be used to address the remaining data requirements.

Bacterial Gene Mutation Assay

Of the Substituted Diphenylamine category materials tested, there was one weakly positive mutagenic response with in the bacterial mutagenicity test, with Benzeneamine, N-phenyl- (122-39-4). Overall weight of evidence for this material, as well as the category indicates a negative evaluation for bacterial mutagenicity.

In vivo Chromosomal Aberration Assays (Mammalian Micronucleus Test)

Two of the nine Substituted Diphenylamine materials have been adequately tested in an *in vivo* chromosomal aberration assay to satisfy HPV requirements. These test materials were negative for clastogenicity.

In vitro Chromosomal Aberration Assay

Two of the nine Substituted Diphenylamine materials have been adequately tested in an *in vitro* chromosomal aberration assay using Chinese hamster ovary cells to satisfy HPV Program requirements. The results of these studies were negative for clastogenicity.

The Substituted Diphenylamines category has been tested for mutagenicity in tests for gene mutations and chromosomal aberrations. The assays included point mutations in bacterial cells, *in vitro* chromosomal aberrations in mammalian cells, and *in vivo* chromosomal aberrations. With one exception, the data consistently demonstrate no evidence of genotoxicity for this category of materials. This suggests that all members of the category lack genotoxicity due to their similarity in chemical structures and physicochemical properties. The similarity of results for genotoxicity supports treatment of these materials as a chemical category within the HPV Challenge Program.

The HPV Challenge Program requires that a gene mutation and a chromosomal aberration test be performed or bridged to each member of a category. For the purposes of the HPV Program, bridging will be used to address the remaining data requirements.

Genotoxicity data will be bridged from Benzenamine, N-phenyl-, styrenated (68442-68-2) Benzenamine, N-phenyl- (184378-08-3) and Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5). Genotoxicity data will be bridged from Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7) to Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3).

By bridging these data, the category has met the requirements of the HPV Challenge Program, and therefore, no additional testing is proposed.

Repeat Dose Toxicity

A summary of the repeat dose toxicity data for the Substituted Diphenylamines category is presented in Table 7.

Benzenamine, N-phenyl – (122-39-4) was tested in a 28 day oral study with rats. A NOAEL of 111 mg/kg/day was identified. Benzenamine, N-phenyl – (122-39-4) is not only the common precursor for the materials of this category, but also theoretically the most toxic of the class since it is the smallest member of the class. The addition of alkyl groups onto the diphenylamine molecule results in even lower water solubility and, therefore, becomes less bioavailable. Benzenamine, N-phenyl-, styrenated (68442-68-2) was tested in a 28-day oral gavage study in rats. A NOAEL of 100 mg/kg/day was identified. Benzenamine, N-phenyl-, styrenated (68442-68-2) was tested in a 28-day gavage study in rats; 100 mg/kg/day was selected as the NOAEL. Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9) was tested in a 64 week rat dietary study; a LOEL of 2500 ppm was identified. Additional adequate repeat dose toxicity studies were not found for the remaining materials in this category. Additional repeat dose testing is not necessary for this category as sufficient testing has been conducted on the smallest molecule in the category for HPV Challenge purposes. The use of this data to represent the remaining larger members of the

category is overly conservative, as the repeated dose toxicity is expected to decrease with increasing molecular weight and with the addition of alkyl groups on the diphenylamine molecule. The addition of alkyl groups onto the diphenylamine molecule results in even lower water solubility and, therefore, becomes less bioavailable. For the purposes of the HPV Program, the existing data can be bridged to the remaining members of this category.

Reproductive and Developmental Toxicity A summary of the reproductive and developmental toxicity data for the Substituted Diphenylamine category is presented in Table 7.

Benzenamine, N-phenyl – (122-39-4) was administered in feed at 0.1, 0.25 or 0.5% (ca. 67, 167 or 333 mg/kg/day) to rats in a two-generation reproductive toxicity study. In general, the average size of the litters decreased as the concentration of dietary diphenylamine increased. A NOEL was not established. A developmental study was also conducted with Benzenamine, N-phenyl – (122-39-4) in rabbits. The test article was administered by gavage at dose levels of 0, 33, 100 and 300 mg/kg/day for gestation days 7-19. The test article produced minimal effects (decreased food consumption and mean body weight) to maternal rats at 300 mg/kg during pregnancy; there were no other signs of maternal toxicity. NOAEL for maternal toxicity was established at 100 mg/kg/day. The NOAEL for teratogenicity/developmental effects was greater than 300 mg/kg/day.

Adequate reproductive and developmental studies are available for Benzenamine, N-phenyl – (122-39-4). Additional reproductive and developmental toxicity testing is not necessary for this category for the HPV purposes as sufficient testing with Benzenamine, N-phenyl – (122-39-4) has been conducted. Benzenamine, N-phenyl – (122-39-4) is not only the common precursor for the materials of this category, but also theoretically the most toxic of the class since it is the smallest member of the class. For meeting requirements of the HPV Program additional reproductive and developmental toxicity testing is not proposed for this category as sufficient testing has been conducted on the smallest molecule in the category. The use of this data to represent the remaining larger members of the category is overly conservative, as the repeated dose toxicity is expected to de crease with increasing molecular weight and with the addition of alkyl groups on the diphenylamine molecule. The addition of alkyl groups onto the diphenylamine molecule results in even lower water solubility and, therefore, becomes less bioavailable. For the purposes of the HPV Program, the existing data can be bridged to the remaining members of this category.

Test Plan

Table 8 provides the category test plan for the Substituted Diphenylamines. The chemicals that constitute the Substituted Diphenylamines category require no additional testing for the purposes of the HPV Program.

FIGURES

Figure 1. Substituted Diphenylamine Structural Definition

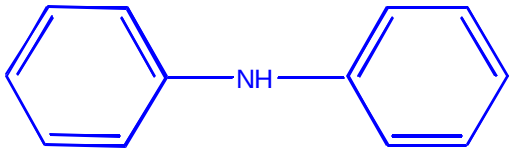
Mononitrogen (N) containing with various degrees of phenyl or alkyl substitution:

Ph-N-Ph

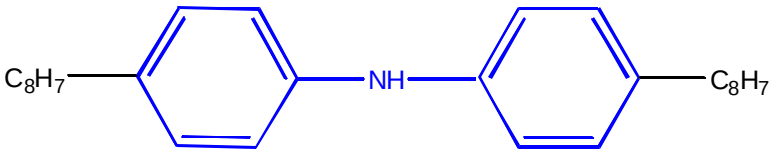
R-Ph-N-R

Where:
Ph = phenyl; R = octyl-, nonyl-, styrenyl-

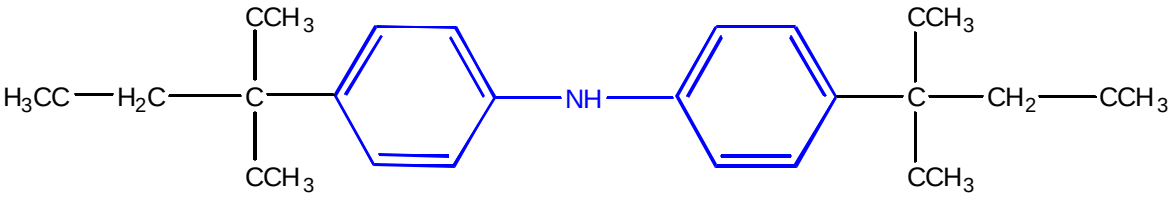
Figure 2 Substituted Diphenylamine Chemical Structures



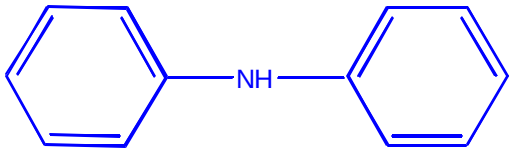
Diphenylamine
122-39-4
Benzenamine, N-phenyl-



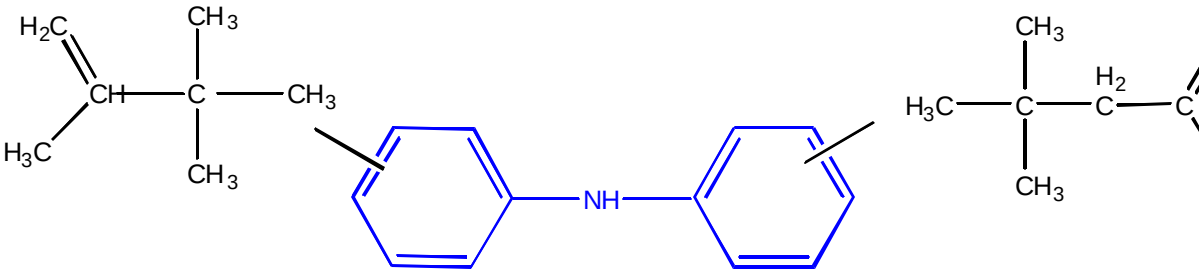
101-67-7
Benzenamine, 4-Octyl-N-(4-octylphenyl)-



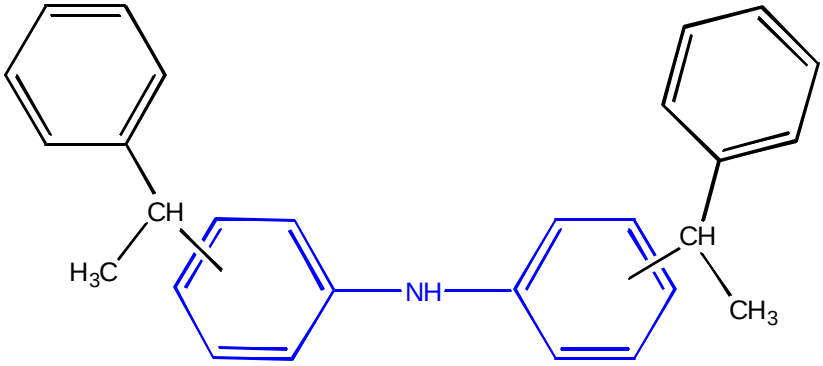
15721-78-5
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]-



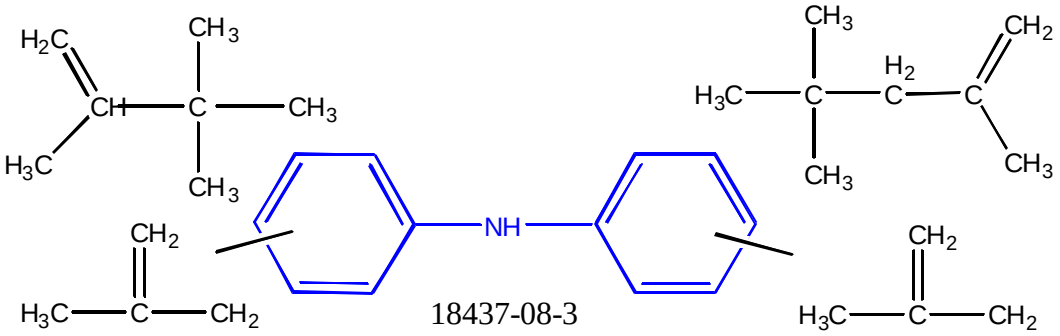
Diphenylamine
122-39-4
Benzenamine, N-phenyl-



68411-46-1
Benzenamine, N-phenyl-, reaction products with 2,2,4-trimethylpentene

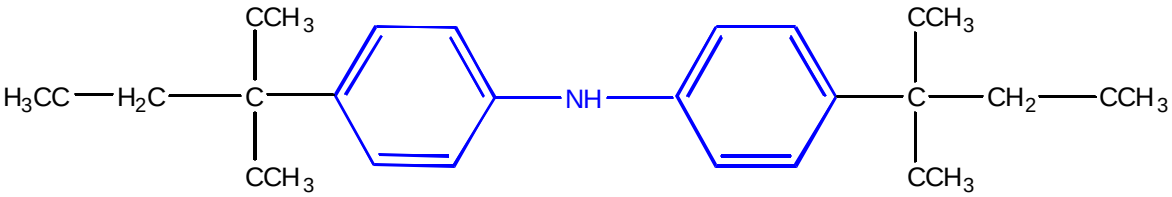


68442-68-2
Benzenamine, N-phenyl-, styrenated



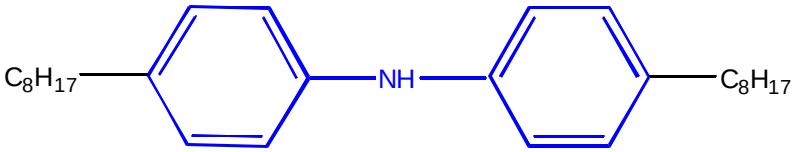
18437-08-3

Benzenamine, N-phenyl, reaction products with 2,2,4-trimethylpentene and isobutylene



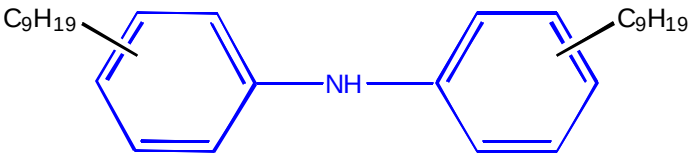
15721-78-5

Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]-



101-67-7

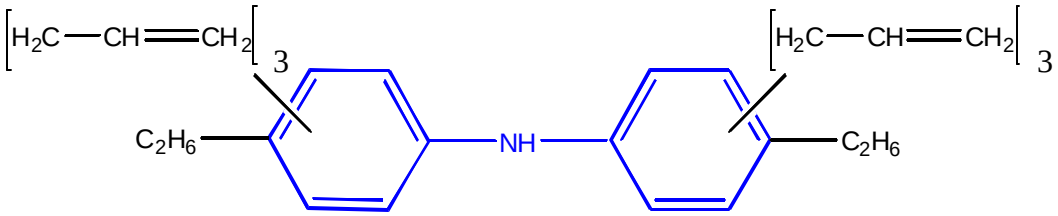
Benzenamine, 4-Octyl-N-(4-octylphenyl)-



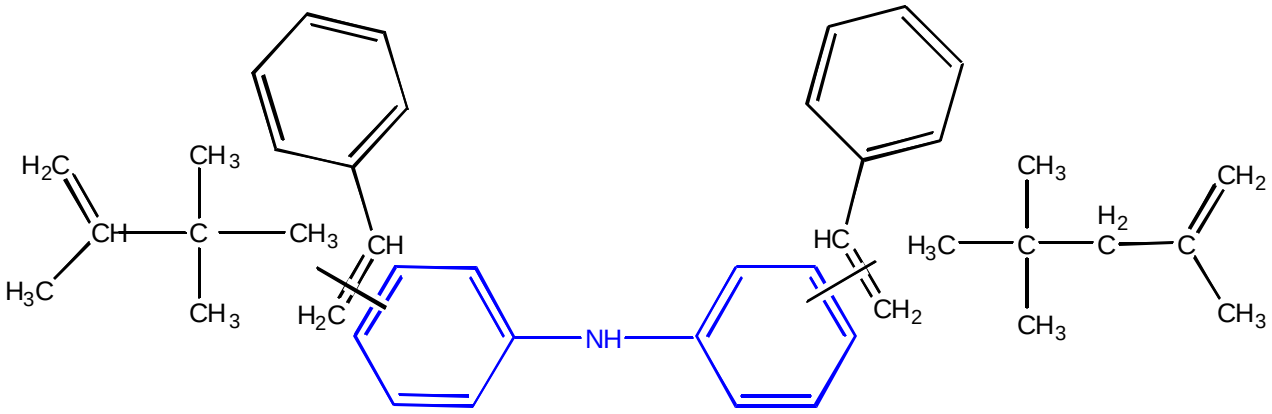
36878-20-3

Benzenamine, ar-nonyl-N-(nonylphenyl)-

Mixed Dinonyldiphenylamines



68608-77-5
Benzenamine, 2-Ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives



68921-45-9
Benzenamine, N-Phenyl, reaction products with Styrene and 2,2,4-Trimethylpentene

TABLES

Table 1. Justification of the Substituted Diphenylamines Category using Flash Point, Vapor Pressure, Water Solubility and Biodegradation

Name (CAS No.)/ Molecular weight	Flash Point (^{o}F)	Vapor Pressure (mm Hg @ 20^{o}C)	Water Solubility	Biodegradability
Benzenamine, N-phenyl- (122-39-4)/169	302	2.2E-4 hPa @ 20C	Very low	Not readily biodegradable
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)/ 298-350	495	2E-5	Insoluble	Not readily biodegradable
Benzenamine, N-phenyl-, styrenated (68442-68-2)/ 320	518	Not determined	Very low	Not readily biodegradable
Benzenamine, N-phenyl- (184378-08-3)/225-393	>356	2E15 @ 25C	Insoluble	Not determined
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)/ 393.66	Not determined	5.05E-9 @25C (EPIWIN)	Negligible	Not readily biodegradable
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)/ 394	415	<0.1	Insoluble	Not determined
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3) / 422	310	Not determined	Insoluble	Not determined
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)/ 225-479	415	2.35E-8 to 9.18E-12 hPa @25C	Insoluble	Not determined
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)/ 225-633	356	9.99E-7 to 1.9E-15 hPa	Negligible	Not determined

Table 2. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Physicochemical Properties

Name (CAS No.)	Melting Point (°C)	Vapor Pressure (mm Hg @ 20°C)	Boiling Point (°C)	Partition Coefficient	Water Solubility (mg/L)
Benzenamine, N-phenyl- (122-39-4)	52.5-55.5	2.2E-4 hPa @ 20C	159 @ 122 hPa	3.5	40
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	44-107	2E-5 @25C	370	>>6	<0.01% @ 20C
Benzenamine, N-phenyl-, styrenated (68442-68-2)	Not determined	Not determined	Not determined	4.64	0.41 @ 20C
Benzenamine, N-phenyl- (184378-08-3)	44-107	2E15 @ 25C	370	>6	<0.01%
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	165.16 (EPIWin)	5.05E-9 @25C (EPIWin)	431.62 (EPIWin)	10.82 (EPIWin)	1.9395E-6 (EPIWin)
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	87-95	<0.1	200	11.26	<0.1 g/100 ml @21C
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	<20 (Room temperature liquid)	Not determined	Not determined	12.24 (KowWin)	Insoluble
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	Not determined	2.35E-8 to 9.18E-12 hPa @25C	443.18 to 547.61	9.84	2.35E-5 to 5.85E-10 @25C
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	Not determined	9.99E-7 to 1.9E-15 hPa	>198C	5.2	0.3889 to 1.869E-11 @ 25C

Table 3. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Environmental Fate

Name (CAS No.)	Hydrolysis	Photo-degradation (t1/2 in hours)	Biodegradation	Environmental Transport
Benzenamine, N-phenyl- (122-39-4)	Not determined	0.642 hours (EPIWin)	0% after 14 days	Primarily to soil and water
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	Not determined	0.053 hours (EPIWin)	Not readily biodegradable	Primarily to soil and sediment
Benzenamine, N-phenyl-, styrenated (68442-68-2)	Not determined	Not determined	9% after 28 days	Not determined
Benzenamine, N-phenyl- (184378-08-3)	Not determined	0.053 days (EPIWin)	Not determined	Primarily to soil and sediment
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	Not determined	0.052 days (EPIWin)	Not readily biodegradable (EPIWin)	Primarily to soil and sediment
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	Not determined	Not determined	Not determined	Not determined
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	Not determined	Not determined	8% after 28 days	Not determined
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	Not determined	0.05 to 0.048 days (EPIWin)	Not determined	Primarily to soil and sediment
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	Not determined	0.051 to 0.053 days (EPIWin)	Not determined	Primarily to soil and sediment

Table 4. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Ecotoxicity

Name (CAS No.)	Acute Fish 96-hour LC50 (mg/l)	Acute Invertebrate 48-hour EC50 (mg/l)	Algal growth inhibition EC50 (mg/l)
Benzenamine, N-phenyl- (122-39-4)	2.2 (48 hr LC50); 7.789 (ECOSAR)	2.3 (24 hr EC50); 9.007 (ECOSAR)	0.18 (biomass); 1.5 (growth rate); 6.065 (ECOSAR)
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	>100	0.82 (24 hrs)	Not determined
Benzenamine, N-phenyl-, styrenated (68442-68-2)	920	Not determined	Not determined
Benzenamine, N-phenyl- (184378-08-3)	Not determined	Not determined	Not determined
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	Not determined	Not determined	Not determined
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	>1000	7.7	>100 (growth rate)
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	>10,000	733	200 (biomass); 600 (growth rate)
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	Not determined	Not determined	Not determined
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	Not determined	Not determined	Not determined

Table 5. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Acute Toxicity

Name (CAS No.)	Acute Oral (mg/kg)	Acute Dermal (mg/kg)
Benzenamine, N-phenyl- (122-39-4)	1165 to >5000	>2000
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	>5000	>2000
Benzenamine, N-phenyl-, styrenated (68442-68-2)	>500->20,000	>10,000
Benzenamine, N-phenyl- (184378-08-3)	Not determined	Not determined
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	Not determined	Not determined
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	>7940	>7940
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	Not determined	Not determined
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	>34,600	>3000
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	Not determined	Not determined

Table 6. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Genotoxicity

Name (CAS No.)	Genotoxicity (*in vitro* bacterial)	Genotoxicity (*in vitro* mammalian)	Genotoxicity (*in vivo*)
Benzenamine, N-phenyl- (122-39-4)	Negative[4]	Negative	Negative
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	Negative	Not determined	Not determined
Benzenamine, N-phenyl-, styrenated (68442-68-2)	Negative	Not determined	Negative
Benzenamine, N-phenyl- (184378-08-3)	Not determined	Not determined	Not determined
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	Not determined	Not determined	Not determined
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	Negative	Negative	Not determined
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	Not determined	Not determined	Not determined
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	Negative	Not determined	Not determined
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	Negative	Not determined	Not determined

[4] Weight of evidence suggests Negative evaluation. One of eight studies showed weak mutagenic activity.

Table 7. Matrix of Available and Adequate Data on Substituted Diphenylamines Category Members Health Effects

Name (CAS No.)	Repeat Dose	Reproductive	Developmental
Benzenamine, N-phenyl- (122-39-4)	28-Day oral with rats. NOAEL = 111 mg/kg/day	Two generation reproductive study in rats	Rabbit gavage NOAEL (maternal) = 100 mg/kg/day; (fetal) >300 mg/kg/day
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	Not determined	Not determined	Not determined
Benzenamine, N-phenyl-, styrenated (68442-68-2)	28-Day oral with rats. NOAEL = 100 mg/kg/day	Not determined	Not determined
Benzenamine, N-phenyl- (184378-08-3)	Not determined	Not determined	Not determined
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	Not determined	Not determined	Not determined
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	Not determined	Not determined	Frog Embryo & Larvae
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	Not determined	Not determined	Not determined
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	Not determined	Not determined	Not determined
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	64 week rat dietary study LOEL = 2500 ppm	Not determined	Not determined

Table 8

Substituted Diphenylamines Category Test Plan

CAS Nos. 122-39-4, 101-67-7, 36878-20-3, 68411-46-1, 68442-68-2, 68608-77-5, 15721-78-5, 68921-45-9 and 184378-08-3

Rubber and Plastic Additives Panel, American Chemistry Council
December 2001

	Physical-Chemical				
CHEMICAL	**Melting Point**	**Boiling Point**	**Vapor Pressure**	**Partition Coefficient**	**Water Solubility**
Benzenamine, N-phenyl- (122-39-4)	A	A	A	A	A
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	A	A	A	A	A
Benzenamine, N-phenyl-, styrenated (68442-68-2)	R	R	R	A	A
Benzenamine, N-phenyl- (184378-08-3)	A	A	A	A	A
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	A (Calc)	A (Calc)	A (Calc)	A (Calc)	A (Calc)
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	A	A	A	A	A
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	A	R	R	A (Calc)	A
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	R	A	A	A	A
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	R	A	A	A	A

Legend	
Symbol	**Description**
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance

NA	Not applicable due to physical/chemical properties

Table 8 (continued)

CHEMICAL	Environmental Fate			
	Photodegradation	Hydrolysis	Environmental Transport	Biodegradation
Benzenamine, N-phenyl- (122-39-4)	A(Calc)	NA	A(Calc)	A
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	A(Calc)	NA	A(Calc)	A
Benzenamine, N-phenyl-, styrenated (68442-68-2)	R	NA	R	A
Benzenamine, N-phenyl- (184378-08-3)	A(Calc)	NA	A(Calc)	R
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	A(Calc)	NA	A(Calc)	A(Calc)
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	R	NA	R	R
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	R	NA	R	A
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	A(Calc)	NA	A(Calc)	R
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	A(Calc)	NA	A(Calc)	R

Legend	
Symbol	**Description**
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance
NA	Not applicable due to physical/chemical properties

Table 8 (continued)

CHEMICAL	Ecotoxicity		
	Acute Toxicity to Fish	Acute Toxicity to Algae	Acute Toxicity to Aquatic Invertebrates (e.g., Daphnia)
Benzenamine, N-phenyl- (122-39-4)	Calc	A	Calc
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	A	R	A
Benzenamine, N-phenyl-, styrenated (68442-68-2)	A	R	R
Benzenamine, N-phenyl- (184378-08-3)	R	R	R
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	R	R	R
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	A	A	A
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	A	A	A
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	R	R	R
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	R	R	R

Legend	
Symbol	**Description**
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance
NA	Not applicable due to physical/chemical properties

Table 8 (continued)

CHEMICAL	Toxicity						
	Acute Toxicity	**Genetic Toxicity *In Vitro (bacterial)***	**Genetic Toxicity *In Vitro (mammalian)***	**Genetic Toxicity *In Vivo***	**Repeat Dose Toxicity**	**Repro-ductive Toxicity**	**Develop-mental Toxicity**
Benzenamine, N-phenyl- (122-39-4)	A	A	A	A	A	A	A
Benzenamine, N-Phenyl-, reaction products with 2,4,4-trimethylpentene (68411-46-1)	A	A	R	R	R	R	R
Benzenamine, N-phenyl-, styrenated (68442-68-2)	A	A	R	A	A	R	R
Benzenamine, N-phenyl- (184378-08-3)	R	R	R	R	R	R	R
Benzenamine, 4-(1,1,3,3-tetramethylbutyl)-N-[4-(1,1,3,3-tetramethylbutyl)phenyl]- (15721-78-5)	R	R	R	R	R	R	R
Benzenamine, 4-Octyl-N-(4-octylphenyl) (101-67-7)	A	A	A	R	R	R	R
Benzenamine, ar-nonyl-N-nonylphenyl (36878-20-3)	R	R	R	R	R	R	R
Benzenamine, 2-ethyl-N-(2-ethylphenyl)-, (tripropenyl) derivatives (68608-77-5)	A	A	R	R	R	R	R
Benzenamine, N-Phenyl-, reaction products with styrene and 2,4,4-trimethylpentene (68921-45-9)	R	A	R	R	A	R	R

Legend	
Symbol	**Description**
R	Endpoint requirement fulfilled using category approach, SAR
Test	Endpoint requirements to be fulfilled with testing
Calc	Endpoint requirement fulfilled based on calculated data
A	Endpoint requirement fulfilled with adequate existing data
NR	Not required per the OECD SIDS guidance
NA	Not applicable due to physical/chemical properties